USE AND CARE OF DIAMOND BITS

by

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INTRODUCTION: - I have been asked to talk to you today about diamond bits as we know them and use them in our drilling work and to tell you something about their manufacture, the different types and grades available and the use and care of them. It might be interesting to you to know something about the value of diamonds as used in diamond bits, where they are found and how mined, the various processes through which they are put before they finally reach you set up in diamond bits, etc.

VALUE: - Do you know that the amount of silver in our silver dollar is valued at approximately 88¢? The gold in a twenty dollar gold piece is actually worth today approximately $32.00? Each of these pieces of money weighs one ounce. A similar weight of diamonds of the type used in one of your diamond bits is worth approximately $1,600.00 or 45 times its weight in gold. Now I know that you have all known about diamonds practically as long as you can remember anything and you have always considered them to be a valuable jewel, but I wonder if you have all thoroughly appreciated the value of a diamond bit when it has come into your possession for use (especially when you have not paid for it out of your own pocket) and the necessity for exercising extreme care and good judgment in the use of that diamond bit.

For instance, if you were to receive a solid gold bit, you would handle it with extreme care because you would consider the fact that it was made out of gold as making it extremely valuable and it would be, but the

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same weight of diamonds would be worth 45 times as much as the gold bit. Of course, you don't get a solid diamond bit anymore than you get a solid gold bit, but I do want to impress upon you the fact that carat for carat diamonds are worth far more than gold.

SOURCE OF DIAMONDS AND HOW MINED: - By far the majority of the industrial diamonds that we use in this country or throughout the free world come from Africa. According to information which has been published covering the diamond production in 1955 on a carat percentage basis, it is noted that the Belgian Congo produced 60.5% with the Union of South Africa 12.1%, the Gold Coast Colony 10.7%, British Southwest Africa 3.58%, Sierra Leone 4.3% and other sources in much smaller quantities. Actually, although the Belgian Congo produced by far the largest amount of industrial diamonds, there are relatively few of the congo diamonds used for diamond drilling. Most all of the diamonds as you know them in your diamond bits are West African bortz and come from the British Southwest Africa or Union of South Africa fields. Much of the congo bortz is crushing bortz and used for industrial diamond wheels, etc. This field is, of course, the largest industrial field for diamond use.

The production of diamonds is not simple. They are not just laying around on the ground to be picked up. Records indicate that 35 tons of dirt or blue ground must be handled or moved in order to obtain one-half carat of jewel diamonds. Of course, the industrial diamonds that you find in your diamond bits are exactly the same type of diamond as the jewel but they are impure and would not be satisfactory as jewels even though they were cut or processed as is the jewel diamond.

You may wonder why man would go to so much trouble merely to find a few diamonds. Leaving the jewel out of the picture, and considering

only the industrial diamond, it is because the diamond is the hardest substance known. There is a vast difference between the hardness of silicon carbides, the next hardest substance, and diamonds.

DIAMONDS AT WORK: - Industrial diamonds are used for many purposes in industry. As we think of industrial diamonds, we think of diamond bits, but there is a far larger consumption of industrial diamonds in other industry uses than in the diamond drilling industry. Grinding wheels for use in machine shops, turning and boring tools, polishing tools and even dentist drills are outlets for industrial diamonds. Many branches of the American industry use industrial diamonds and the mining industry of which diamond drilling must be considered a part along with the construction industry, provides only a relatively small outfit for the vast quantity of industrial diamonds imported into this country.

TYPES AND KINDS OF INDUSTRIAL DIAMONDS: - There are many different types and sizes as well as grades of industrial diamonds and it is necessary that a manufacturer of diamond bits, such as Sprague & Henwood, carry a very large inventory of diamonds in order that we can meet the needs of our own Contract Drilling Department and those of our customers who favor us with their orders for diamonds bits. As stated before, there are several different grades of diamonds with a different price for each grade and each grade has various size groups. From this you can well imagine that an inventory of many hundreds of thousands of dollars in value must be carried.

When a shipment of new diamonds is received at our plant, it is necessary that these diamonds are put through various processes including that of sifting the diamonds for size and sorting the diamonds for quality. The diamonds are sized by passing them through different size sieves, but each stone is examined individually by an expert who grades it into one of

the various grades which it is necessary to have.

SETTING DIAMOND BITS: - To a group of individuals familiar with diamond drilling and with diamond bits, it is hardly necessary to describe in detail each step employed in the setting of a diamond bit, but I would like to say that it is quite a process involving, first of all, a knowledge as to the number of carats required in the bit, the grade of diamonds to be used, the size of diamonds desired, the type of matrix required, etc. Through the various steps in our Diamond Department, the proper diamonds finally reach the girls who do the actual setting of the stones in the molds before they are sent to the men in the shop for the actual mechanical work of setting in the bit. Each girl has been specially trained for performing a certain function in the setting of the diamond bit and the mechanics in the shop also have their particular job to do and they soon become experts in performing that particular function.

COMPARISONABLE STYLE CARBON BITS AND PRESENT DAY BORTZ DIAMOND BITS: - I would like to call your attention to the following comparison of present day bortz diamond bits with the old style black diamond or carbon bit. There are not too many drillers now employed in actual drilling operations who ever used the carbon bit, but I am sure some of the older engineers and supervisors remember them very well. Up until the early 1930's, the black diamond or carbon bit was in almost universal use in the industry. In the late 20's some attempts had been made to use bortz diamonds but these early attempts met with little or no success.

You might be interested in knowing something of the value of the black diamond or carbon bit as compared to the bortz diamond bit. A very common size bit in the old days was the 2" diameter bit. This bit was usually set with 8 diamonds which were set by hand by drilling four holes

on the outside periphery equally spaced and four on the inside periphery and then caulking the diamond in place by hand. The diamonds were set so that they would overlap on the face of the bit to give complete coverage as well as to provide cutting clearance on both the inside and outside edge of the bit. Usually when three or more drills were employed on a drilling project, one or more diamond setters were employed right in the field and very often the diamond setter doubled as a foreman on the job.

A 2" diamond bit set as described above might contain carbons weighing approximately 2 carats each. Since the bit contained 8 diamonds, this meant that there was approximately 16 carats in the bit and with a first-grade carbon diamond being valued at approximately $150.00 per carat, it meant that a 2" diamond bit of this kind was worth approximately $2,400.00. A size AX bit today which is approximately the same size, set with first quality bortz diamonds is valued at approximately $130.00. This is quite a difference. However, it must be remembered that a diamond bit is still a pretty valuable item and should be treated with extreme care when being used.

WHERE WE OBTAIN DIAMONDS: - We obtain our new diamonds from various sources although most of them are obtained direct from the Diamond Syndicate in London. We do get some of our diamonds from various dealers in this country but they originally obtained their supply of diamonds from the Diamond Syndicate also. The Diamond Syndicate controls the output of most of the world's diamonds and because they do, they also control the price. It is because of this that we know what other suppliers of diamond bits have to pay for their diamonds and therefore we are convinced that when some other manufacturer or dealer in diamond bits offers to furnish diamond bits at a considerably lower price than that for which we can supply the bit, he must

be offering a different quality diamond. Of course, we always have to expect that there might be a slight difference because one supplier might be satisfied with a smaller margin of profit than another, but when the difference is a way out-of-line, there can only be one answer - either the quality of the diamonds used is less or the supplier expects to make up the difference in some other way. We all know that no one is in business to lose money and must make a profit to stay in business.

KIND OF DIAMOND BITS WE CAN FURNISH: - Sprague & Henwood, Incorporated have three standard grades of West African bortz diamonds and two grades of congo diamonds that we regularly offer in our diamond bits. These grades are known as our grade AAA, grade AA and grade A for the West African bortz and grade C-1 and C-2 for the congo diamonds. We can set these diamonds in the four different types of matrices. The TRUCAST matrix and the TRUCAST H matrix are the cast set type and the TUFSET matrix and the ROSSSETmatrix are the powdered metal types. The TRUCAST matrix is a beryllium copper alloy and the TRUCAST H matrix is a beryllium nickel alloy. The TUFSET matrix is a tungsten alloy and the ROSSSET matrix is a tungsten carbide powdered metal. The TRUCAST or beryllium copper cast set bit and the TUFSET powdered metal bit are not as hard a matrix as the TRUCAST H beryllium nickel or the ROSSSET tungsten carbide. In general, we recommend the use of the TUFSET matrix where there is not much abrasive action on the part of the strata being drilled and the diamonds wear or polish necessitating resetting of the bit before the matrix wears. Where there is abrasive action on the part of the strata being drilled which causes the matrix to wear away while the diamonds are still cutting satisfactorily, then we recommend the use of the ROSSSET or the TRUCAST H matrix. As previously stated, in addition to being graded for quality,

diamonds are also divided into various size groups. Our standard sizes run from 14 to 20 per carat; 20 to 30; 30 to 40; 40 to 60; 60 to 80 and 80 to 100, all figures being per carat. The size of stone which should be used, depends upon the character of the rock being drilled. While it doesn't always run true to form, in general, we recommend the use of small stones when cutting hard rock and the larger stones when cutting the softer shales or sandstones. Bits can, of course, be furnished with 2, 3, 4 or more waterways, or without any waterways, if desired, and believe me we have calls for all types.

The congo diamonds are not considered to be as hard as the West African bortz diamonds and are generally larger in size. We, therefore, use congo diamonds in some of the larger diameter bits and particularly for drilling concrete or some of the softer stratas.

Another type of diamond bit which is available is the impregnated bit. In this type of bit fragmented bortz diamonds are used and these fragments are impregnated throughout the 1/4 to 3/8 inch thick working part of the matrix. We recommend this bit for use in badly broken formations where the average diamond bit would be badly damaged and it can also be used for drilling through boulders where it is felt necessary to use a diamond bit. In fact, it may be said that the impregnated diamond bit can be used in any tough drilling situation where ordinary steel or hard tipped bits will not serve the purpose and yet the formation is too broken to justify the use of a regular surface set type of diamond bit. The impregnated bit is costly, however, and should be used only where it is felt that it is justified due to conditions. The impregnated type of bit has no salvage value and should be run to destruction. Sometimes if the strata being drilled is not abrasive enough to wear away the matrix and

thus expose the diamonds, it is necessary to sandblast the bit to renew its cutting efficiency.

It is important to all of you to bear in mind that a surface set diamond bit which is the type you use almost exclusively, has a definite salvage value and the bit should not be run too long before being returned for salvage and resetting. It is impossible for anybody to tell you exactly when a diamond bit should be removed from operation and sent back for resetting. It is something you have to learn from experience and for which you develop an instinct as to when it is the proper time to remove a bit from operation. More damage can be done to a diamond bit by running it one foot longer than it should be run than in all of the drilling done down to that point. Everytime the bit is removed from the hole, the driller should examine it carefully and decide whether or not he believes that the bit should be put back in the hole for more drilling or returned for salvage and resetting.

I don't know whether or not you are all familiar with the procedure followed in resetting diamond bits. However, let me say that when a diamond bit has been used and returned to us for resetting, all diamonds are removed from the old bit and sufficient new bortz diamonds are added to bring the bit up to its original carat content.

To illustrate, if a new AX bit with TUFSET matrix and grade AAA bortz diamonds is worth $127.40 when purchased new and it is returned for resetting, it may be that there will be a salvage of 6 carats which means that 4 carats of new diamonds will have to be added. The 4 carats of grade AAA bortz diamonds added at $11.50 per carat will amount to $46.00. The cost of furnishing the blank bit and resetting is $12.40, so the total cost of the reset bit is $58.40 as compared to the original cost of

the new bit of $127.40. You can readily see, therefore, that the more salvage there is in a returned bit the lower the cost of the reset bit. It behooves everyone of you, therefore, to exercise care in the use of diamond bits and to return them for resetting at the proper time. However, it would be false economy to return a bit too soon before the maximum amount of service had been obtained from same.

PROPER USE OF A DIAMOND BIT: - I cannot overemphasize the fact that a diamond bit is a valuable tool and must be handled with care. Too often a driller puts a diamond bit in a hole without exercising due care in seeing that it is not running over a broken piece of core left in the hole from the previous run or a piece of the sidewall of the hole which might have dropped in when the bit was withdrawn previously. To run a diamond bit over a loose piece of rock in the bottom of the hole will do considerable damage to the bit before it actually starts to do any drilling at all. The driller should make sure that the hole is clean and that the bit is solidly on the bottom before he puts his power on the bit for its drilling run.

It is also important that when the core becomes blocked that the bit be removed from the hole rather than to run with blocked core and grind the rock away. This is also extremely hard on diamonds and results in poor footage being obtained from a diamond bit and high cost results. A little more care being exercised in the use of diamond bits will result in lower diamond bit cost and this is important to everyone of us.

What I have said about the use of diamond bits applies not only to the use of Sprague & Henwood bits but any diamond bits with which you are furnished.

ORIENTATION: - You have probably heard much about the crystallographic

orientation of diamonds when setting them in drilling bits. This sounds as though it might be a very complicated and technical operation but, as a matter of fact, it merely means the orienting or setting of the diamonds with the hard vector of the diamonds set in the direction of the drilling. Of course, there is the correct method of doing this to get the most efficiency out of the bit and since this is done by what may be called a "trade secret" process I am not at liberty to go into detail regarding this method of setting.

There have been arguments both pro and con as to the value of orientation of diamonds in drilling bits, but from our experience orienting diamonds in drilling bits is practical and that diamond drilling costs are usually substantially reduced through the use of oriented bits. When orientation was first developed we charged more for an oriented bit, but now all of Sprague & Henwood bits are set by the orientation process at no extra cost to the purchaser or user.

I might say a little more about the proper operation and use of diamond bits.

It is important that when operating a diamond bit the correct rotation speeds and correct pressures be used. It is recognized that in drilling operations, progress is important to ultimate cost. Therefore, it would be poor economy to run a bit slow or at too low a pressure just to prevent wear on the diamond bit, since drilling progress would also be retarded. It is important, therefore, that the drill operator determine as soon as possible the speed and pressure at which he gets the best results both from the standpoint of drilling progress and diamond bit life.

Running a bit at too fast a rotation speed at an improper low pressure in hard rock will cause the diamonds to polish and thus lose their

cutting efficiency. All rocks do not require the same amount of pressure or the same rotating speed and it is important that the right kind of combination of speed and pressure, according to the character of the rock being drilled, is important to the life of a diamond bit. The amount of footage obtained from the bit and the rate of drilling progress obtained.

Another matter which is important to the life of a diamond bit is the water which is used to cool the bit and to wash the cuttings and carry them to the surface. It is important that the bit be properly cooled and too often a bit is damaged by "burning" which, of course, means that it has been overheated due to lack of an adequate water passage at the face of the bit. Too often, the drill operator walks away from the drill hole while the diamond bit is being used and fails to note the action of the bit which indicates the loss of water until it is too late. It is obvious that a diamond bit should never be run without proper cooling action, but too often carelessness on the part of the drill operator results in bits which have been damaged or even ruined because they were run too long without adequate water.

In general, I believe it is safe to say that a surface set diamond bit should never be used for drilling in overburden. This is a good rule to follow although it is recognized that there are exceptions to all rules and occasionally under certain conditions it might be expedient to use a diamond bit through certain types of overburden, but it should only be done after careful consideration and authorization by whatever supervisory personnel is attached to the drilling work.

I like to take the stand that a diamond bit should never be used for drilling through overburden - particularly a surface set diamond bit. Loose gravel or boulders encountered in overburden will tear out the

diamonds in a surface set diamond bit very often and the cost of these diamonds will in almost every case be more than the cost of drilling through the overburden by some other method, even though progress is not as fast. If drilling through overburden becomes necessary, use a sawtooth bit, a tungsten carbide insert type bit, fishtail bits or possibly impregnated bits.

Of course, large boulders have to be drilled in order to get through them, but this can hardly be classed as overburden drilling. In such cases, the drive pipe is set on the boulder and the diamond bit is used the same as if you were drilling bedrock, but when the boulder has been drilled the diamond bit should be removed and the work of getting through the overburden continued by some other method.

I hope I have given you something to think about and something that will help you as you use diamond bits in your drilling operations in the future.

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